

# Nonspherical Microcapsules for Increased Core Content Volume Delivery

Completed Technology Project (2011 - 2013)



## Project Introduction

If systems such as wiring insulation, inflatables, and habitation structures had a way to automatically heal tears, abrasions, and other damage, that ability would significantly increase their reliability, reduce their life cycle costs, and improve the safety of the operations and larger systems they support (commercial and defense aircraft, extended space missions, surface exploration, etc.). Kennedy Space Center (KSC) has been developing self-healing technologies for wiring systems and has established intellectual property in this area. One of KSC's approaches is encapsulating healants in spherical microcapsules so they can be released automatically when the system is damaged. The healant fills the voids that form as the damage occurs. But to overcome challenges in spherical microencapsulation, innovative ideas and approaches are required.

The goal of this project was to advance microencapsulation from the standard spherical microcapsule to a non-spherical, high-aspect ratio (HAR), elongated microcapsule. This was to be accomplished by developing reproducible methods of synthesizing or fabricating robust, non-spherical, HAR microcapsules. An additional goal of this project was to develop the techniques to the point where scale-up of these methods could be examined. Additionally, this project investigated ways to apply the microencapsulation techniques developed as part of this project to self-healing formulations.

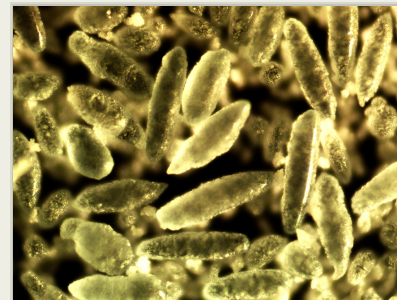
This project had three primary objectives, all of which have been addressed:

- Assess the state-of-the-art for microcapsules and self-healing systems;
- Evaluate reproducible methods of synthesizing or fabricating robust, nonspherical microcapsules and develop new technology where applicable;
- Evaluate the use of nonspherical microcapsules in self-healing applications such as wire insulation

## Anticipated Benefits

Flexible, high performance polymers such as polyimides are often employed in aerospace applications. They typically find uses in areas where improved physical characteristics such as fire resistance, long term thermal stability, and solvent resistance are required. It is anticipated that such polymers could find uses in future long duration exploration missions as well. Their use would be even more advantageous if self-healing capability or mechanisms could be incorporated into these polymers.

This technology provides game changing impacts for deep space exploration and habitation missions, as well as satellites, military, and commercial aviation needs could be expected. Potentially significantly reduce life cycle cost and increase safety; increase reliability by at least 2X, and mission availability to



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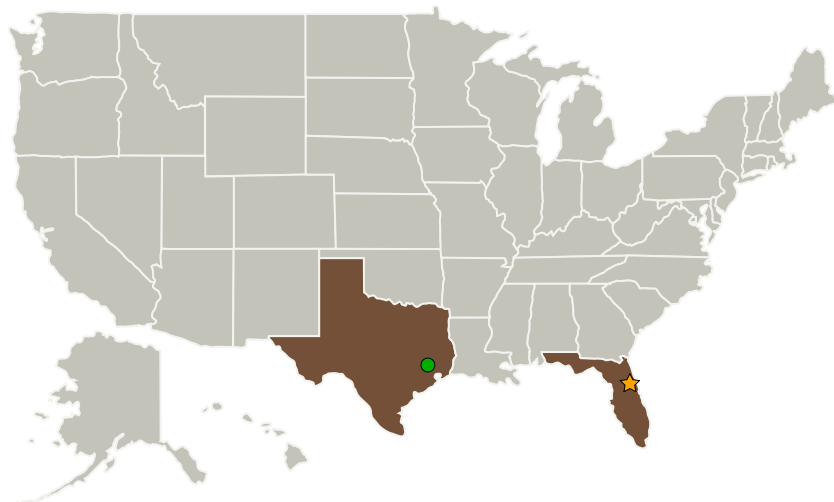
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at least 200%.

Self-healing or self-sealing capabilities would significantly reduce maintenance requirements, and increase the safety and reliability of high performance wiring systems. A patent was filed for this method of synthesizing non-spherical microcapsules in 2012. Additional intellectual property is expected when the method is reduced to practice and when risk mitigation technologies are developed for core removal/ replacement and perhaps microfluidic systems. Self healing technologies would also be very beneficial to satellites, military and commercial aviation needs.

## Primary U.S. Work Locations and Key Partners



## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Kennedy Space Center (KSC)

### Responsible Program:

Center Innovation Fund: KSC CIF

## Project Management

### Program Director:

Michael R Lapointe

### Program Manager:

Barbara L Brown

### Project Manager:

Nancy P Zeitlin

### Principal Investigator:

Martha K Williams

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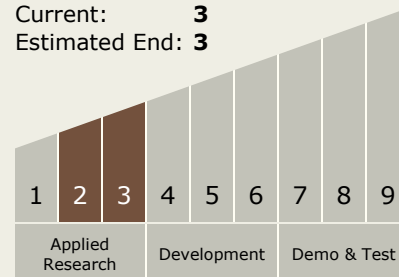
Organizations Performing Work	Role	Type	Location
★ Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Florida Institute of Technology	Supporting Organization	Academia	Melbourne, Florida
● Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
QinetiQ North America(QNA)	Supporting Organization	Industry	
TE Connectivity	Supporting Organization	Industry	

Co-Funding Partners	Type	Location
Florida Space Grant Consortium(FSGC)	Academia	Orlando, Florida

Primary U.S. Work Locations	
Florida	Texas

## Technology Maturity (TRL)

Start: **2**  
 Current: **3**  
 Estimated End: **3**



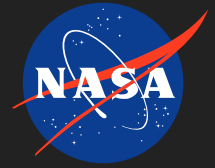
## Technology Areas

### Primary:

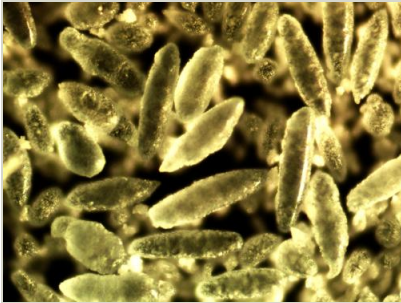
- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.4 Information Processing
  - TX11.4.7 Digital Assistant

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## Images



### **Optical micrograph of nonspherical, high-aspect-ratio microcapsules.**

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(<https://techport.nasa.gov/image/2122>)